



LANDSAT DATA CONTINUITY MISSION

LDCM Launch Services - Interface Requirements Document

Effective Date:February 07, 2012

Expiration Date:February 07, 2017



**Goddard Space Flight Center
Greenbelt, Maryland**

National Aeronautics and
Space Administration

CHECK THE LDCM CM WEBSITE AT:
<https://cicero.eos.nasa.gov/bin/lbcm/login.cgi>
TO VERIFY THAT THIS IS THE CORRECT VERSION PRIOR TO USE.

CM Foreword

This document is a Landsat Data Continuity Mission (LDCM) Project Configuration Management (CM)-controlled document. Changes to this document require prior approval of the applicable Configuration Control Board (CCB) Chairperson or designee. Proposed changes shall be submitted to the LDCM CM Office (CMO), along with supportive material justifying the proposed change. Changes to this document will be made by complete revision.

Questions or comments concerning this document should be addressed to:

LDCM Configuration Management Office
Mail Stop 427
Goddard Space Flight Center
Greenbelt, Maryland 20771

Signature Page

Prepared by:

Concurrence on File **01/04/12**

Mike Goeser
LDCM Launch Vehicle Integration
Manager
NASA/GSFC – Code 427

Date

Reviewed by:

Concurrence on File	02/03/12	Concurrence on File	02/03/12
Evan H. Webb LDCM Mission Systems Manager NASA/GSFC – Code 599	Date	Del T. Jenstrom LDCM Deputy Project Manager NASA/GSFC – Code 427	Date

Concurrence on File **12/14/12**

William C. Anselm
LDCM Observatory Manager
NASA/GSFC – Code 427

Date

Approved by:

Signature on File (D. Jenstrom for) **02/07/12**

Kenneth Schwer
LDCM Project Manager
NASA/GSFC – Code 427

Date

Table of Contents

1	INTRODUCTION	Error! Bookmark not defined.
1.1	DOCUMENT PURPOSE	Error! Bookmark not defined.
1.2	DOCUMENT OBJECTIVES	1
1.3	DOCUMENT SCOPE	1
2	APPLICABLE DOCUMENTS	2
3	INTERFACE REQUIREMENTS	3
3.1	MECHANICAL.....	3
3.1.1	Structural Interfaces	3
3.1.1.1	Spacecraft Coordinate System.....	3
3.1.1.2	Spacecraft Center of Gravity	4
3.1.1.3	Launch Vehicle Adapter Interface.....	4
3.1.1.4	Launch Vehicle Fairing	4
3.1.1.5	Spacecraft Access Requirements.....	4
3.1.1.6	Spacecraft Instrument Purge Requirements	4
3.1.1.7	Spacecraft Mission Logo Requirement	4
3.1.2	Structural Characteristics/Loads	5
3.1.2.1	Stiffness	5
3.1.2.2	Acceleration Load Factors.....	5
3.1.2.3	Interface Loads	5
3.1.2.4	Strength.....	5
3.2	ELECTRICAL	5
3.2.1	Airborne Interfaces.....	6
3.2.1.1	Interface Connectors.....	6
3.2.1.2	Separation Interface Constraints.....	6
3.2.1.3	Pre-Separation Spacecraft Power On	6
3.2.1.4	Separation Indication	7
3.2.1.5	Umbilical Power Interfaces	7
3.2.2	GSE Interfaces	7
3.2.2.1	Ground Interfaces	7
3.2.2.1.1	Electrical Connectors at the EGSE Room/Umbilical Interface	8
3.2.2.1.2	Ground Telemetry and Command Interface.....	8
3.2.2.2	EGSE Power	8
3.2.3	Telemetry and Command Interfaces	8
3.2.3.1	Command Interface	8
3.2.3.2	Ground Telemetry Interface	9

3.2.3.3	LV Ascent Interleaved Telemetry Interface	9
3.2.4	Electrical Bonding and Grounding.....	9
3.2.4.1	Structure Bonding.....	9
3.2.4.2	Spacecraft Grounding	9
3.2.4.3	Support Equipment and GSE Grounding	9
3.2.4.4	Personnel Grounding	9
3.2.4.5	Grounding Continuity.....	10
3.3	ENVIRONMENTS	10
3.3.1	Temperature and Humidity	10
3.3.1.1	Ground Transport Temperature & Humidity.....	10
3.3.1.2	Payload Fairing (PLF) Air Flow, Temperature, and Humidity Constraints	10
3.3.2	Contamination	11
3.3.2.1	Spacecraft Contaminant Deposition Limits.....	11
3.3.2.1.1	Particulate.....	11
3.3.2.1.2	Molecular	11
3.3.2.2	Payload Compartment Surface Cleanliness.....	12
3.3.2.2.1	Payload Compartment Particulate Levels	12
3.3.2.2.2	Payload Compartment Non-Volatile Residue	12
3.3.2.3	Windborne Contamination	12
3.3.2.4	Launch Vehicle Materials Control	12
3.3.2.5	Spacecraft Purge	12
3.3.2.5.1	Transport to Launch Pad	12
3.3.2.5.2	On-Pad.....	12
3.3.2.6	Launch Vehicle Debris	12
3.3.2.7	Witness Plate Provisions	12
3.3.2.8	Spacecraft Processing Facility.....	13
3.3.3	Pressure	13
3.3.3.1	Ascent Pressure Profile Constraints	13
3.3.3.2	Spacecraft Venting	13
3.3.3.3	On-Pad Air Conditioning Impingement Velocity Constraint.....	13
3.3.4	Dynamic Environments.....	13
3.3.4.1	Acoustics	13
3.3.4.2	Sine Vibration.....	13
3.3.4.3	Shock	14
3.3.5	Electromagnetic Compatibility	14
3.3.5.1	Electromagnetic Interference Requirements	14
3.3.5.1.1	EMI Safety Margin.....	14
3.3.5.1.2	SC Radiated Emissions/LV Susceptibility.....	14
3.3.5.1.3	Radiated Susceptibility for RF Environment	14

3.3.5.1.4	Lightning Protection.....	14
3.4	FLIGHT DESIGN.....	15
3.4.1	Performance	15
3.4.1.1	Performance Reserves	15
3.4.1.2	Launch Opportunities	15
3.4.1.3	Reference Mission	15
3.4.1.3.1	Reference Mass	15
3.4.1.3.2	Reference Mission Target Orbit Requirements.....	15
3.4.2	Launch Window	15
3.4.3	Ascent Heating	16
3.4.4	Attitude Requirements	16
3.4.4.1	Sun Angles.....	16
3.4.4.2	Thermal Attitude.....	16
3.4.5	Separation.....	16
3.4.5.1	Attitude	16
3.4.5.2	Pointing Accuracy and Body Rates	16
3.4.5.3	Separation Velocity	16
3.4.5.4	Separation Attitude Rate.....	17
3.4.5.5	Separation Time.....	17
3.5	FLIGHT OPERATIONS	17
3.5.1	Telemetry & Tracking.....	17
3.5.2	Acquisition Assistance	17
3.5.3	In-Flight Video.....	17
3.6	GROUND OPERATIONS	17
3.6.1	Facility Requirements	17
3.6.2	Transport Requirements	18
3.6.3	Payload Fairing Purge at the Launch Site	18
3.6.4	Spacecraft Access.....	18
3.6.5	Communications	18
3.6.6	Propellants, Fluids and Gases	19
3.7	SAFETY	19
3.7.1	Safety Design Requirements	19
3.7.2	Hazardous Systems/ Elements	20
3.7.3	Hazardous Operations	20

4	Appendix A	21
---	------------------	----

Table of Figures

Figure 3 - 1 LDCM Observatory in Stowed Configuration 3

Table of Tables

Table 2 - 1 Government Applicable Documents	2
Table 3 - 1 Maximum Spacecraft CG Load Factors	5
Table 3 - 2 Connector Part Numbers	6
Table 3 - 3 Controlled Thermal Environment for Ground Handling in the PPF	10

1 INTRODUCTION

1.1 DOCUMENT PURPOSE

This document defines the Landsat Data Continuity Mission (LDCM) to Launch Services interface requirements and constraints necessary to assure technical compatibility.

1.2 DOCUMENT OBJECTIVES

This document provides the definition of the LDCM Observatory to Launch Vehicle interface requirements as necessary to permit their design and implementation. In addition, it identifies integration and test facility requirements and mission operations support requirements at the launch site.

1.3 DOCUMENT SCOPE

This set of requirements defines the necessary elements of the LV interface in order to procure a launch service for this mission. As the Spacecraft design evolves, the LDCM Project will participate with the NASA/KSC in the Mission Integration Team (MIT) process to develop the specific requirements and document them in the appropriate Interface Control Document (ICD).

2 APPLICABLE DOCUMENTS

Table 2 - 1 Government Applicable Documents

Document Number	Revision/ Release Date	Document Title
FED-STD-209E	Rev. D, 15 June 1998	Airborne Particulate Cleanliness, Cleanrooms and Clean Zones
ASTM E595	2006	Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment
MIL-PRF-27401F	January 10, 2008	Propellant Pressurizing Agent, Nitrogen
AFSPCMAN 91-710 (Vol. 1-7)	1 July 2004	Air Force Space Command Manual 91-710 Range Safety User Requirements
IEEST-STD-CC1246D	Rev. D, 15 Feb 2002	Product Cleanliness Levels And Contamination Control Program
NIMA TR8350.2	3 rd Edition, Amendment 1, dated 3 January 2000	Department of Defense World Geodetic System 1984
NPR 8715.6A	May 14, 2009	NASA Procedural Requirements for Limiting Orbital Debris

3 INTERFACE REQUIREMENTS

This section establishes the Launch Vehicle System interface design requirements for the LDCM Observatory.

LSIRD-42 The environments specified in this document have been levied as requirements on the SC design. The Launch Services Contractor (LSC) shall indicate compliance and margin against these requirements.

LSIRD-623 Any exceptions to the requirements in this document shall be reviewed and approved by the SC project.

3.1 MECHANICAL

3.1.1 Structural Interfaces

The structural interfaces between the spacecraft (SC) and launch vehicle (LV) consist of the clampband interface between the SC and LV Payload Adapter (PLA), payload fairing, electrical connections through the PLA using two (2) in-flight disconnects, and a GN2 purge line in-flight disconnect.

3.1.1.1 Spacecraft Coordinate System

LSIRD-47 The LDCM SC reference coordinate system shall be as defined in Figure 3-1 below and in the LV Interface Control Document (ICD) Requirement Number 1100.

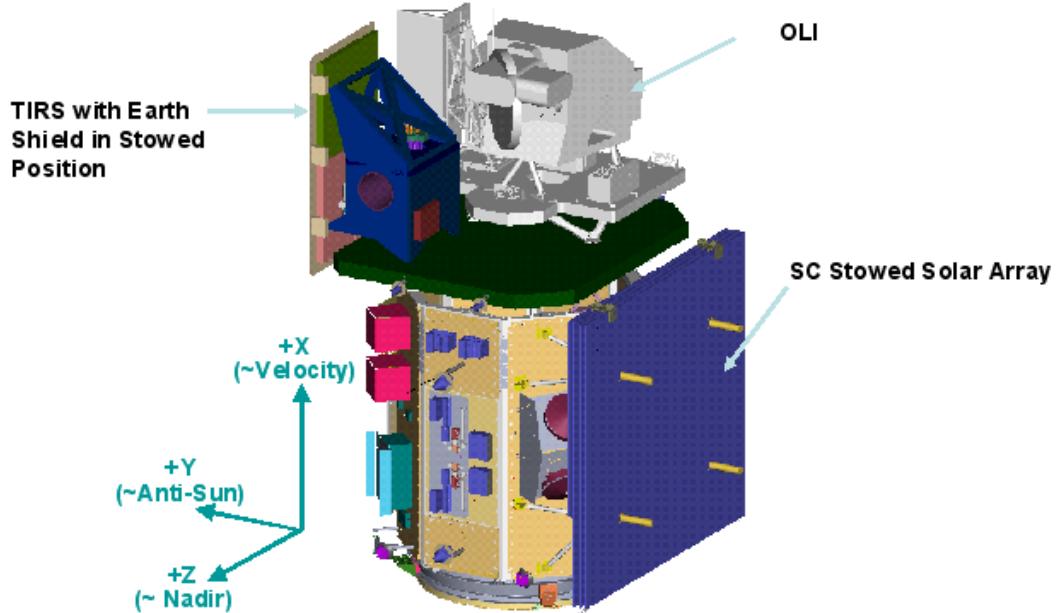


Figure 3 - 1 LDCM Observatory in Stowed Configuration

3.1.1.2 Spacecraft Center of Gravity

- LSIRD-777 The SC longitudinal center of gravity (CG) shall be as defined in LV ICD Requirement Number 1300.
- LSIRD-780 The SC lateral CG offset from the longitudinal axis of the SC shall be as defined in LV ICD Requirement Number 1300.

3.1.1.3 Launch Vehicle Adapter Interface

- LSIRD-50 The SC shall have a LSPSS 1666 mm diameter clampband separation system mechanical interface as defined in LV ICD Requirement Number 1115.
- LSIRD-670 The LSC shall provide a LSPSS 1666 mm clampband separation system with standard separation springs in standard spring locations as defined in LV ICD Requirement Number 1115.

3.1.1.4 Launch Vehicle Fairing

- LSIRD-52 The SC in a stowed configuration shall fit within the payload fairing volume as defined in LV ICD Requirement Number 1105.
- LSIRD-671 The LSC shall provide the payload fairing volume as defined in LV ICD Requirement Number 1105.

3.1.1.5 Spacecraft Access Requirements

- LSIRD-54 The LV shall provide up to three (3) payload fairing doors to access SC items after encapsulation as defined in LV ICD Requirement Number 1100.

3.1.1.6 Spacecraft Instrument Purge Requirements

- LSIRD-56 The Launch Service Contractor (LSC) shall purge the observatory and instruments from a single interface connector that supports the purge rate and maximum pressure as defined in LV ICD Requirement Number 3600.
- LSIRD-607 The LSC shall supply the GN2 purge interface to the SC as defined in LV ICD Requirement Number 1100.
- LSIRD-608 The SC shall supply purge gas distribution from the SC in-flight disconnect to the Observatory instruments.

3.1.1.7 Spacecraft Mission Logo Requirement

- LSIRD-58 The LDCM Project Office shall prepare and deliver to the LSC the flight approved LDCM mission logo drawing to be placed on the external surface of the payload fairing.
- LSIRD-609 The LSC shall prepare and place the mission logo on the payload fairing as defined in LV ICD Requirement Number 1100.

3.1.2 Structural Characteristics/Loads

3.1.2.1 Stiffness

[LSIRD-61](#) The SC structural stiffness shall be as defined in LV ICD Requirement Number 1206.

3.1.2.2 Acceleration Load Factors

[LSIRD-63](#) The LV induced load factors on the SC center of gravity shall not exceed those shown in Table 3-1. This is based on meeting the SC stiffness requirements of Section 3.1.2.1.

Table 3 - 1 Maximum Spacecraft CG Load Factors

Flight Event	Axial Load Factor (g) ¹	Lateral Load Factor (g)
BECO (Max Axial)	6.0	+/- 0.5
BECO (Max Lateral)	4.0	+/- 1.5
	-1.0	+/- 1.5
MECO (Max Lateral)	-2.0	+/- 0.6
Flight Winds	3.3	+/- 2.0
	0.5	+/- 2.0

Note 1. + (Positive)=Compression; - (Negative)=Tension

3.1.2.3 Interface Loads

[LSIRD-68](#) The LSC shall provide the maximum line load capability at the SC/LV clampband interface as defined in LV ICD Requirement Number 1200.

[LSIRD-726](#) The SC shall design to the maximum line load capability and the maximum SC peaking factors at the SC/LV clampband interface as defined in LV ICD Requirement Numbers 1200 and 1205.

3.1.2.4 Strength

[LSIRD-70](#) The SC and LV interface shall support the SC during the maximum loading condition as defined in LV ICD Requirement Number 1207.

3.2 ELECTRICAL

[LSIRD-72](#) The LV system shall provide electrical interconnection between the SC and LV from the time of SC to LV PLA mate until SC separation from the launch vehicle as defined in LV ICD Requirement Number 2100.

3.2.1 Airborne Interfaces

3.2.1.1 Interface Connectors

LSIRD-75 The LV system shall provide two 61-pin connector interfaces between the LV and the SC as defined in LV ICD Requirement Number 2105. The connector types and characteristics are listed in Table 3-3.

LSIRD-76 The LV System shall provide LDCM with three (3) full Flight sets (both sides of the connector) of these connectors.

LSIRD-610 The SC side of the connector shall be used as the flight disconnect.

Table 3 - 2 Connector Part Numbers

Item	Part Number	Number of Contacts
Connectors on Spacecraft	MS3464E61-50S and MS3464E61-50SY	61
Connectors on Launch Vehicle	MS3446E61-50P and MS3446E61-50PY	61

3.2.1.2 Separation Interface Constraints

LSIRD-92 At the events of liftoff and SC/LV separation when electrical connectors are to be separated, the current on any line shall not exceed 100 millamps as defined in LV ICD Requirement Numbers 2130 and 2205.

3.2.1.3 Pre-Separation Spacecraft Power On

LSIRD-781 The SC shall be capable of being commanded to power on before separation from the LV.

LSIRD-697 The LSC shall provide two (2) normally open switch closure circuits through the LV to SC electrical interface connectors as defined in LV ICD Requirement Number 2150.

LSIRD-782 Each LSC-provided switch closure circuit shall be changed from open to closed circuit continuously for at least 67 seconds upon command enable from the LV. The SC has a persistency count duration of 32 seconds on this interface signal. Therefore, the switch closure circuit needs to remain in the closed position, glitch free, for the entire 67 second duration.

LSIRD-783 Each LSC-provided switch closure circuit shall be compatible with a 3.3 VDC pull-up resistor circuit (**using a 1.21 Kohm resistor**) on the SC side of the interface.

LSIRD-698 Each LSC-provided switch closure circuit shall be routed through a separate electrical interface connector as defined in LV ICD Requirement Number 2100.

LSIRD-699 The LSC-provided switch closure command event shall be enabled after Centaur MECO and at least 6 minutes prior to the SC separation event.

3.2.1.4 Separation Indication

LSIRD-94 The LV shall monitor separation circuits and telemeter verification of the SC separation event.

LSIRD-95 The SC shall provide one breakwire/separation signal for sensing by the LV in each interface connector as defined in LV ICD Requirement Number 2110. There are two (2) pins required in each interface connector.

LSIRD-611 These breakwires shall be isolated from SC structure by a minimum of 1 megaohm.

LSIRD-612 The characteristics of these loopback circuits on the SC shall be as follows:

Maximum mated resistance: 1 ohm

Minimum separated resistance: 1 megaohm

LSIRD-98 The LV shall provide three (3) separation breakwires for sensing by the SC in each interface connector as defined in LV ICD Requirement Number 2115.

3.2.1.5 Umbilical Power Interfaces

LSIRD-102 The LSC ground facility shall provide the power sources and connectors as defined in Item 1 of LV ICD Table 3.5.1-2.

LSIRD-103 The LSC ground facility shall provide the source voltage and current as defined in LV ICD Table 3.5.1-2.

LSIRD-106 The maximum round-trip resistance between the SC and the EGSE room shall be 1.0 ohm, or less, as defined in LV ICD Requirement Number 2100.

LSIRD-107 The SC Power Circuit return lines at the SC EGSE power source shall be isolated from earth ground by 1 +0.1/- 0.001 Mega-ohm by the SC provider.

LSIRD-672 The power return lines at the SC EGSE power source shall be referenced to a single point ground at the payload structure.

3.2.2 GSE Interfaces

3.2.2.1 Ground Interfaces

LSIRD-110 The LV Ground Facility shall provide an EGSE Room with an SC Interface Panel for both power and command to, and sensor signals and power from, the SC as defined in LV ICD Requirement Number 2100.

LSIRD-615 The LSC Ground Facility shall provide dedicated “feedthrough” cabling from the SC/LV interface, through an LV Umbilical, to the SC Interface Panel as defined in LV ICD Requirement Number 2100.

LSIRD-616 Cabling connectivity provided by the LSC shall be available from the time the T-0 Umbilical is connected until it is disconnected at liftoff.

3.2.2.1.1 Electrical Connectors at the EGSE Room/Umbilical Interface

LSIRD-112 The SC Electrical Ground Support Equipment (EGSE) interface connection shall be at the EGSE Room Interface Panel as defined in LV ICD Requirement Number 2100.

LSIRD-617 The LSC shall provide space within the EGSE Room such that the maximum distance between the SC EGSE and the EGSE Room Interface Panel is less than 15 feet.

LSIRD-618 The LSC Ground Facility shall provide the mating halves of the electrical connectors for the EGSE side.

3.2.2.1.2 Ground Telemetry and Command Interface

LSIRD-721 The LSC shall provide electrical connections that support a data rate of 32.0 kbps +/- 0.5 kbps for the command interface (unencrypted) between the SC on the pad and the SC Control Room.

LSIRD-741 The LSC shall provide electrical connections that support a data rate of 64.0 kbps +/- 0.5 kbps for the command interface (encrypted) between the SC on the pad and the SC Control Room.

LSIRD-722 The LSC shall provide electrical connections that support a data rate of 1.0 Mbps. +/- 25 kbps for the telemetry interface between the SC on the pad and the SC Control Room.

3.2.2.2 EGSE Power

LSIRD-114 The LSC Ground Facility shall provide uninterruptible power to the SC EGSE as defined in LV ICD Table 3.5.1-2.

3.2.3 Telemetry and Command Interfaces

3.2.3.1 Command Interface

LSIRD-134 Two sets of (one set for encrypted commands and one set for unencrypted commands) prime and redundant uplink command interface shall be provided by the LSC through the umbilicals to facilitate Spacecraft commanding while on the Launch Pad as defined in LV ICD Requirement Number 2100.

3.2.3.2 Ground Telemetry Interface

[LSIRD-136](#) A prime and redundant downlink telemetry interface shall be provided by the LSC through the umbilical to facilitate SC telemetry on the Launch Pad as defined in LV ICD Requirement Number 2100.

3.2.3.3 LV Ascent Interleaved Telemetry Interface

[LSIRD-701](#) The LSC shall provide an interface to the LV S-Band telemetry system that supports two channels of SC telemetry at a data rate of 2 +/- 0.05 kbps each during launch and ascent until SC separation from the LV as defined in LV ICD Requirement Number 2700.

[LSIRD-723](#) The SC shall provide a redundant RS-422 interface to the LV that is compatible with parallel termination resistance on the LV side of the RS-422 interface.

[LSIRD-742](#) KSC shall strip the SC telemetry out of the LV telemetry stream during launch and ascent and provide it to LDCM.

3.2.4 Electrical Bonding and Grounding

3.2.4.1 Structure Bonding

[LSIRD-139](#) The electrical bonding resistance between the SC and LV shall be 2.5 milliohms or less as defined in LV ICD Requirement Number 2145.

3.2.4.2 Spacecraft Grounding

[LSIRD-141](#) The NASA/KSC-provided PPF shall provide an earth referenced facility ground attachment point for use during LV and SC integration and encapsulation.

[LSIRD-619](#) The LSC shall provide a grounding cable that connects the LV, and subsequently the SC via the launch vehicle, to the earth referenced facility ground point during hoisting and mating to the LV.

3.2.4.3 Support Equipment and GSE Grounding

[LSIRD-143](#) The LSC shall provide earth referenced facility ground attachment points at launch site locations for grounding SC ground support equipment.

[LSIRD-620](#) The SC shall provide all cables and attach hardware to connect the ground support equipment to the facility grounds.

3.2.4.4 Personnel Grounding

[LSIRD-145](#) The LSC shall provide/identify an area on the LV for attachment of personnel grounding straps during launch site SC operations.

3.2.4.5 Grounding Continuity

LSIRD-147 The resistance between the earth reference ground attachment points defined in Sections 3.2.4.2, 3.2.4.3, and 3.2.4.4 and the associated facility ground rods shall be 1 ohm or less.

3.3 ENVIRONMENTS

The following environments have been levied on the spacecraft.

The ground operations and handling estimates encompass the environments which the SC hardware may encounter during assembly level fabrication, integration, calibration, and pre-launch operations. The ground handling environments also include transportation and storage of the hardware in shipping containers.

3.3.1 Temperature and Humidity

LSIRD-152 Temperature, pressure and humidity for ground operations such as assembly and system level testing, launch site operations and temporary storage shall be maintained by the NASA/KSC Payload Processing Facility (PPF) provider.

LSIRD-785 The NASA/KSC PPF provider shall maintain the controlled thermal and humidity environment for LDCM flight hardware during ground processing operations in the PPF as defined in Table 3-5.

3.3.1.1 Ground Transport Temperature & Humidity

LSIRD-154 The LSC shall maintain the controlled thermal and humidity environment for LDCM flight hardware during ground transport as defined in LV ICD Requirement Number 3100.

Table 3 - 3 Controlled Thermal Environment for Ground Handling in the PPF

Control Parameter	Low Limit	High Limit
Temperature	16°C	22°C
Relative Humidity	30%	55%

3.3.1.2 Payload Fairing (PLF) Air Flow, Temperature, and Humidity Constraints

LSIRD-172 The LSC shall supply temperature-and humidity-controlled air and airflow distribution within the PLF with periods of interruption to be negotiated in the SC to LV ICD.

LSIRD-173 The LSC fairing air conditioning system at the launch pad shall be operated continuously for a period of time before the SC arrival at the launch pad to verify the system is ready for use.

LSIRD-174 The LSC air conditioning system shall provide fairing air as defined in LV ICD Requirement Number 3100.

Note: LV and SC operations must keep in mind that the humidity will go to zero at the start of tanking during the launch count as GN2 is used.

LSIRD-175 The fairing air conditioning shall be as defined in LV ICD Requirement Numbers 3203 and 3204.

LSIRD-621 The air shall be continuously monitored by the LSC for particulates at the inlet to the fairing.

LSIRD-622 Notification by the LSC shall be provided to the SC contractor when the air exceeds class 1000 per FED-STD-209E.

LSIRD-703 The LSC payload fairing air distribution system shall provide air conditioning flow directly to the spacecraft's battery radiator as defined in LV ICD Requirement Number 3125.

LSIRD-787 The LSC-provided battery air conditioning shall provide for heat transfer coefficients from the SC battery as defined in LV ICD Requirement Number 3125. The SC battery radiator has a surface area of 0.67 m² (1.0 m long x 0.67 m wide).

LSIRD-937 The LSC-provided battery air conditioning shall provide for a maximum impingement velocity on the SC battery radiator as defined in LV ICD Requirement Number 3130.

3.3.2 Contamination

3.3.2.1 Spacecraft Contaminant Deposition Limits

3.3.2.1.1 Particulate

LSIRD-181 Particulate contamination levels on the SC from all launch system sources from SC encapsulation through the Collision and Contamination Avoidance Maneuver (CCAM) shall not exceed the surface obscuration level defined in LV ICD Requirement Number 3210.

3.3.2.1.2 Molecular

LSIRD-183 Molecular contamination levels on the SC from all launch system sources from SC encapsulation through CCAM shall not exceed the level defined in LV ICD Requirement Number 3205.

3.3.2.2 Payload Compartment Surface Cleanliness

3.3.2.2.1 Payload Compartment Particulate Levels

LSIRD-186 The PLF interior surfaces and Payload Adaptor surfaces shall be cleaned and verified to meet level 400 per IEST-STD-CC1246D.

3.3.2.2.2 Payload Compartment Non-Volatile Residue

LSIRD-188 The PLF and LV surfaces to which the SC is exposed shall be cleaned and verified to meet level A per IEST-STD-CC1246D.

3.3.2.3 Windborne Contamination

LSIRD-190 The LSC shall provide protection to the SC from windborne contamination and maintain the cleanliness levels from fairing encapsulation through liftoff.

3.3.2.4 Launch Vehicle Materials Control

LSIRD-192 Nonmetallic materials within the LV PLF volume shall not exceed a total mass loss of 1.0% and volatile condensable materials within the LV PLF volume shall not exceed 0.1% when tested per ASTM E-595 or equivalent method as defined in LV ICD Requirement number 3220.

3.3.2.5 Spacecraft Purge

3.3.2.5.1 Transport to Launch Pad

LSIRD-195 The LSC shall provide a continuous GN2 purge as defined in LV ICD Requirement Number 3605 via the purge in-flight disconnect to protect the science instruments from humidity and contamination during transportation preparations and transportation from the integration facilities to the launch pad.

3.3.2.5.2 On-Pad

LSIRD-197 The LSC shall provide a continuous GN2 purge as defined in LV ICD Requirement Number 3605 via the purge in-flight disconnect to protect the science instruments from humidity and contamination while at the launch pad including during hoist operations for SC to LV mate.

3.3.2.6 Launch Vehicle Debris

3.3.2.7 Witness Plate Provisions

LSIRD-201 Fallout witness plates (one for NVR and two for particulates) shall be mounted inside the payload fairing volume by the LSC as defined in LV ICD

Requirement Number 3215. The witness plates will be used to monitor particulate and nonvolatile residue contamination inside the fairing.

LSIRD-203

The witness plates shall be installed and changed out as defined by LV ICD Requirement Number 3216.

LSIRD-624

At PLF close-out, the witness plates shall be removed by the LSC as defined by LV ICD Requirement Number 3216.

LSIRD-204

The LSC shall provide the witness plates and brackets, change witness plates as required, process the witness plates, and provide the resulting data to the spacecraft.

3.3.2.8 Spacecraft Processing Facility

LSIRD-206 The NASA/KSC provided PPF provider shall provide services which meet or exceed class 10,000 per FED-STD-209E in the PPF.

3.3.3 Pressure

3.3.3.1 Ascent Pressure Profile Constraints

LSIRD-209 The LSC shall provide the ascent pressure profile as defined in LV ICD Requirement Number 3300.

3.3.3.2 Spacecraft Venting

LSIRD-211 The SC shall be designed to satisfy the LV ascent pressure profile as defined in LV ICD Requirement Number 3300.

3.3.3.3 On-Pad Air Conditioning Impingement Velocity Constraint

LSIRD-213 The LV payload fairing air distribution system shall not duct the conditioned air flow directly onto the spacecraft's instruments.

3.3.4 Dynamic Environments

3.3.4.1 Acoustics

LSIRD-216 The maximum expected flight acoustic environment from the LV shall be as defined in LV ICD Requirement Number 3410.

3.3.4.2 Sine Vibration

LSIRD-307 The maximum expected lower frequency sine vibration environment from the LV shall be as defined in LV ICD Requirement Number 3410.

3.3.4.3 Shock

[LSIRD-338](#) The maximum LV induced shock environment at the SC separation plane shall be as defined in LV ICD Requirement Number 3420.

3.3.5 Electromagnetic Compatibility

3.3.5.1 Electromagnetic Interference Requirements

3.3.5.1.1 *EMI Safety Margin*

[LSIRD-357](#) The SC system shall demonstrate an Electro-Magnetic Interference Safety Margin (EMISM) to the RF environment (vs. dc no-fire threshold) for all EED circuits as defined in LV ICD Requirement Number 3500.

[LSIRD-358](#) The SC and LV systems shall demonstrate an EMISM to the RF environment for all safety critical circuits and circuits that could propagate a failure to the launch vehicle as defined in LV ICD Requirement Number 3500.

[LSIRD-359](#) Other circuits - The SC shall demonstrate a 0 dB EMISM for all other circuits.

3.3.5.1.2 *SC Radiated Emissions/LV Susceptibility*

[LSIRD-361](#) The SC shall not emit electromagnetic fields at the LV/SC interface in excess of the levels defined in LV ICD Requirement Number 3510.

[LSIRD-625](#) The LV shall be compatible with the limits as defined in LV ICD Requirement Number 3505.

3.3.5.1.3 *Radiated Susceptibility for RF Environment*

[LSIRD-396](#) The SC shall show compatibility with the range RF environment as defined in LV ICD Section Number 3.3.5.2.4 and LV ICD Requirement Numbers 3511 and 3515.

3.3.5.1.4 *Lightning Protection*

[LSIRD-459](#) The Launch Service Provider shall provide protection from direct lightning strikes. The SC provider is responsible for ensuring compatibility to induced lightning effects.

3.4 FLIGHT DESIGN

3.4.1 Performance

3.4.1.1 Performance Reserves

- [LSIRD-463](#) In all cases, adequate performance reserve shall be held by the launch service contractor to ensure a minimum three sigma probability of a guidance commanded shutdown of the final stage of the launch vehicle.
- [LSIRD-626](#) The launch service contractor shall also allocate reserves to account for seasonal performance effects and environmental dispersions (temperature and upper level winds).
- [LSIRD-938](#) The launch service contractor shall also allocate reserves to account for disposal of the Centaur upper stage as defined in LV ICD Requirement Number 4405.

3.4.1.2 Launch Opportunities

- [LSIRD-465](#) The LV shall be able to support a launch attempt on any day of the year.

3.4.1.3 Reference Mission

3.4.1.3.1 Reference Mass

- [LSIRD-468](#) The reference separated SC mass shall be less than or equal to the contract SC mass as defined in LV ICD Requirement Number 4100.

3.4.1.3.2 Reference Mission Target Orbit Requirements

- [LSIRD-470](#) The LSC shall target the Spacecraft injection orbit as defined in LV ICD Requirement Number 4200.
- [LSIRD-704](#) The LSC target orbit parameters and 3-sigma dispersions shall be defined at the first descending node following separation.
- [LSIRD-705](#) The LSC target orbit parameters shall be defined using True of Date (TOD) coordinates.
- [LSIRD-706](#) The LSC target orbit parameters shall be defined using the Earth's radius and gravity model as defined by the World Geodetic System 1984 (WGS-84) in LV ICD Requirement Number 4200.

3.4.2 Launch Window

- [LSIRD-500](#) The LV shall be capable of supporting a launch window as defined in LV ICD Section 3.4.5.2 and LV ICD Requirement Number 4410.

3.4.3 Ascent Heating

LSIRD-502 The three sigma dispersed free molecular heating (FMH) rate shall not exceed the limit at payload fairing jettison or any point thereafter during the LV mission as defined in LV ICD Requirement Number 3120.

3.4.4 Attitude Requirements

3.4.4.1 Sun Angles

LSIRD-505 The LSC shall point the SC solar Array (SC -Y axis) towards the sun to the greatest extent possible during the coast phase from the time of Centaur MECO until eclipse entry.

3.4.4.2 Thermal Attitude

LSIRD-507 The LV shall be capable of implementing a thermal (“barbeque”) roll during orbital coast phases as defined in LV ICD Requirement Number 4205.

LSIRD-630 During the thermal roll, the longitudinal axis of the LV shall be oriented to a payload specified sun-relative attitude.

LSIRD-673 During the thermal roll the LV shall implement a spin rate as defined in LV ICD Requirement Number 4205.

3.4.5 Separation

3.4.5.1 Attitude

LSIRD-510 Prior to SC separation and at the time of LV Attitude Control System inhibit, the LV shall point the SC +X axis at the Sun as defined in LV ICD Requirement Number 4300.

LSIRD-631 The LV shall be capable of inhibiting the upper stage Attitude Control System during the separation event.

3.4.5.2 Pointing Accuracy and Body Rates

LSIRD-512 Prior to SC separation, at the time of LV Attitude Control System inhibit, the LV pointing error shall be as defined in LV ICD Requirement Number 4300.

3.4.5.3 Separation Velocity

LSIRD-715 The LSC provided payload separation system shall function so as to preclude recontact of the LV with the SC after separation (clampband release) as defined in LV ICD Requirement Number 4300.

3.4.5.4 Separation Attitude Rate

- [LSIRD-648](#) The LV provided payload separation system shall impart a total angular momentum onto the SC after separation (clampband release) as defined in LV ICD Requirement Number 4300.
- [LSIRD-719](#) The SC shall have the capability to accommodate a total angular momentum after separation of 90 N-m-s, 3-sigma.

3.4.5.5 Separation Time

- [LSIRD-812](#) The LSC shall provide for SC separation at a point in the flight as defined in LV ICD Requirement Number 4300.

3.5 FLIGHT OPERATIONS

3.5.1 Telemetry & Tracking

- [LSIRD-517](#) Tracking and telemetry from the launch vehicle shall be provided by the LSC for powered flight activities and Spacecraft separation.

3.5.2 Acquisition Assistance

- [LSIRD-519](#) The LSC shall provide the LDCM Project with an Orbital Parameters Message (OPM) based upon upper stage telemetry data. It is anticipated the OPM will arrive at the LDCM Mission Operations Center within 30 minutes of Spacecraft separation.
- [LSIRD-632](#) The launch service provider shall support OPM delivery both by fax and electronic transmission.

3.5.3 In-Flight Video

- [LSIRD-814](#) The LSC shall provide a standard video package for in-flight video with one camera on the outside of the LV facing aft and one camera facing forward with artificial lighting to show SC separation.

3.6 GROUND OPERATIONS

3.6.1 Facility Requirements

- [LSIRD-522](#) The SC shall maintain its Spacecraft Control Center at the NASA/KSC provided facilities.
- [LSIRD-716](#) The NASA/ KSC provided PPF shall provide protection for COMSEC equipment.

- [LSIRD-717](#) The LSC shall provide access control of the 'Spacecraft processing area' at a level compliant with COMSEC security protection while mated to the LV.
- [LSIRD-523](#) The LSC shall provide a LV EGSE room for SC equipment necessary to provide power and command/TLM to/from the SC through the collocated LV EGSE interface panel.
- [LSIRD-524](#) The LSC shall provide a Mobile Service Tower (or equivalent) area, adjacent to the SC payload fairing access doors, for SC closeout operations and launch preparations.
- [LSIRD-525](#) The LSC shall provide for the setup and control of a SC-provided GN2 purge panel for the continuous purge of the instruments starting from encapsulation through SC mate to the LV.
- [LSIRD-941](#) The LSC shall provide a purge panel on the pad to supply a dedicated SC Instrument GN2 purge from the end of SC mate to the LV through T-0.
- [LSIRD-942](#) The LSC shall provide and install additional SC-specified filtration downstream of the LVC purge control panel on the pad.

3.6.2 Transport Requirements

- [LSIRD-527](#) Transportation of the SC from the PPF to the launch complex shall be provided by the LSC.
- [LSIRD-688](#) Transportation of the SC EGSE from the PPF to the launch complex shall be provided by the NASA/KSC PPF provider.
- [LSIRD-633](#) Maximum dynamic environments for the SC during transportation from the PPF to the launch pad shall be bounded by the environments defined in LV ICD Requirement Number 5400.

3.6.3 Payload Fairing Purge at the Launch Site

- [LSIRD-533](#) Air or GN2 flow to the Payload Fairing shall be maintained such that a positive pressure relative to the surrounding environment exists at all times except for brief outages agreed to between the LSC and SC.

3.6.4 Spacecraft Access

- [LSIRD-535](#) The LSC shall provide a clean enclosure to control the environment around the mission unique door opening in the PLF at the launch pad as defined in LV ICD Requirement Number 3235.

3.6.5 Communications

- [LSIRD-537](#) The Launch Service Contractor shall provide telephone access and voice net communications in the following locations:

1. The launch complex SC test area on the pad, from SC arrival to launch closeout operations

2. LV EGSE room, from EGSE arrival to pad clear for terminal countdown

LSIRD-816 The NASA/KSC PPF provider shall provide telephone access and voice net communications in the SC Control Room.

LSIRD-817 The NASA/KSC PPF provider shall provide an analog phone line in the clean room for the GN2 purge suitcase autodialer.

LSIRD-544 The LSC shall provide continuous video coverage in the LV EGSE room from EGSE arrival to T-0.

LSIRD-818 The NASA/KSC PPF provider shall provide continuous video coverage as defined in the Launch Site Support Plan.

LSIRD-548 The Launch Service Contractor shall provide ethernet data connectivity between the LV EGSE room (interface panel) and the Spacecraft Control Room.

3.6.6 Propellants, Fluids and Gases

LSIRD-552 The Spacecraft shall have the capability for emergency propellant off-load at the launch complex.

LSIRD-596 In the event an emergency Spacecraft propellant off-load is required, the LSC shall provide the facilities for accepting and disposing of the propellants through its launch complex hazardous fluid containment/removal system.

LSIRD-597 The Spacecraft shall provide interconnect lines between the Spacecraft fill & drain valves and the launch complex tank drain and vent interfaces to be used in the event an emergency propellant off-load is required.

3.7 SAFETY

LSIRD-554 The SC shall comply with the requirements of AFSPCMAN 91-710 or an approved tailored version as defined in LV ICD Requirement Number 6005.

3.7.1 Safety Design Requirements

LSIRD-556 The LSC shall accommodate access through the payload fairing to the SC propellant and nitrogen service valves to accommodate contingency propellant

offload beginning with encapsulation as defined in LV ICD Requirement Number 1100 and the MICD.

3.7.2 Hazardous Systems/ Elements

Hazardous elements may include a propulsion subsystem, pressure vessels containing high-pressure nitrogen, ordnance, RF subsystem, batteries, and mechanisms.

[LSIRD-559](#) Spacecraft hazardous systems shall be detailed in the SC Missile System Prelaunch Safety Package.

3.7.3 Hazardous Operations

[LSIRD-561](#) The SC hazardous operations shall be detailed in the SC Missile System Prelaunch Safety Package.

4 Appendix A

BECO	Booster Engine Cutoff
CCAM	Collision and Contamination Avoidance Maneuver
CCB	Common Core Booster
CG	Center of Gravity
COMSEC	Communications Security
EED	Electro-Explosive Device
EGSE	Electrical Ground Support Equipment
EMISM	Electro-Magnetic Interference Safety Margin
EPF	Extended Payload Fairing
FMH	Free Molecular Heating
GDAIS	General Dynamics Advanced Information Systems
GN2	Gaseous Nitrogen
GSE	Ground Support Equipment
ICD	Interface Control Document
I/F	Interface
KSC	Kennedy Space Center
LDCM	Landsat Data Continuity Mission
LSC	Launch Service Contractor
LSPSS	Low Shock Payload Separation System
LSSP	Launch Site Support Plan
LV	The NASA/KSC contracted launch vehicle
MECO	Main Engine Cutoff
MGSE	Mechanical Ground Support Equipment
MIT	Mission Integration Team
MLT-DN	Mean Local Time - Descending Node
MST	Mobile Service Tower
NASA	National Aeronautics and Space Administration
OASPL	Overall Sound Pressure Level
OLI	Operational Land Imager
OPM	Orbital Parameters Message
PLA	Payload Adapter
PLF	Payload Fairing
PPF	Payload Processing Facility
PRD	Program Requirements Document
SC	The LDCM Observatory or Spacecraft Bus
SIL	Software Integration Lab
SLC 3E	Space Launch Complex 3 East
SPL	Sound Pressure Level
TBD	To Be Determined

TBR	To Be Resolved
THD	Total Harmonic Distortion
TIRS	Thermal Infrared Sensor
Tx	Transmission
VAFB	Vandenberg Air Force Base